

PATTERNS OF INDUSTRIAL DEVELOPMENT IN COSTA RICA: EMPIRICAL ‘VALIDATION’ OF A FIRM–BASED GROWTH MODEL^a

Tommaso Ciarli

Centre for the research of employment on development, Bologna

ciarli@economia.unife.it

Globelics Academy 2005

Instituto Superior Tecnico, IST

Lisbon, May 23 – June 03

^aThe empirical analysis has been carried with Elisa Giuliani, who has undergone the fieldwork. The model has been fitted from continuous interactions with Marco Valente

Presentation Outline

- Introduction: paper and model aims
- Methodological approach
- Main indicators from the empirical case: Costa Rican industrial development
- The interpretative model
- Model behaviour and experiments
- Final considerations on Costa Rican development

Aim of the paper

Interpret (possibly explain) patterns of industrial development in developing countries moulding together appreciative theorising and qualitative simulation modelling.

- Methodological framework
- Empirical analysis (ex ante) \mapsto process and determinants of industrial development in Costa Rica: how do systemic and micro changes interact?
- Theoretical analysis (generalising) \mapsto implement an interpretative simulation model using *also* information from the empirical evidence on the micro behaviour
- Theoretical analysis (ex post) \mapsto simulate and interpret patterns of industrial development from the bottom–up. How do different micro and institutional settings affect the aggregate dynamics? Interpreting the interaction between systemic and micro changes in Costa Rica

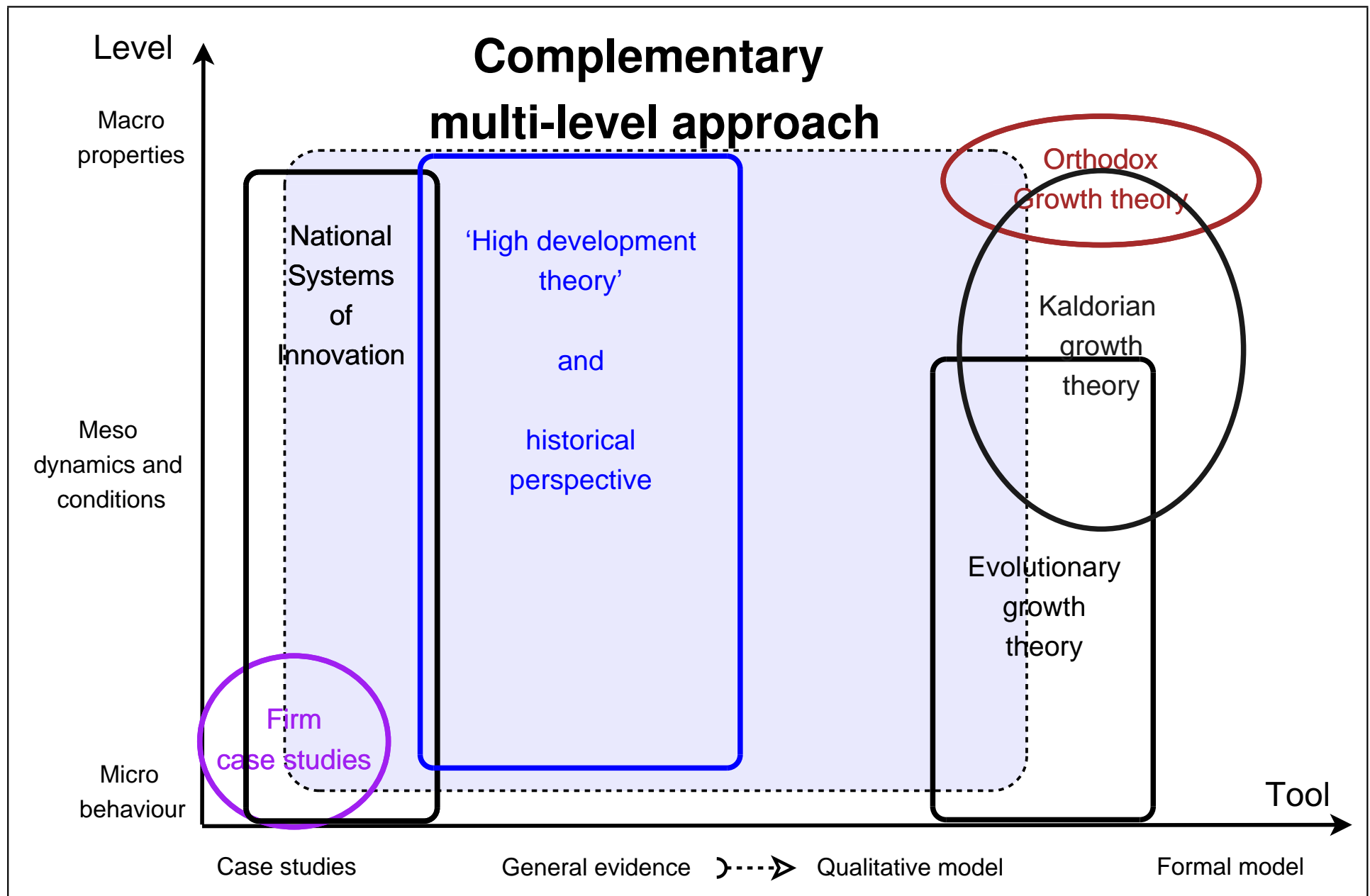
A methodological claim

- How useful is orthodox growth theory to explain development phenomena?
 \hookrightarrow provides a formal *representation* of *aggregate growth* phenomena.
- How far can appreciative theorising (or historical counts) on particular case studies generalise from idiosyncratic and contextual determinants to wider regularities?
 \hookrightarrow an understanding trade-off between localised and general evidence: *no inference*.
- Which level of socio/economic aggregation (economic object) should be studied/represented in the analysis of complex phenomena such as development?



We need both a *complementary* and *multi-level* perspective

- complement different analytical tools, both empirical and theoretical
- analyse the interactions between different levels of economic aggregates (micro to macro)



A methodological proposal

- ✓ Observe a number of empirical regularities and causal mechanisms at different levels of economic aggregation (different economic objects): *ex post* analysis.
- ✓ Build ‘virtual worlds’ in which objects behaviours are represented at different levels: heterogeneous agents, bounded by normative behaviour, within economic settings...

⇓
abduction

- ✓ Observe and explain the mechanisms through which higher level aggregates originate from interactions between lower level objects: *emergentism*
- ✓ Observe the effects of higher level changes on lower level objects’ behaviour, state, and mechanisms of emergence: *second order emergence*

⇓
experimenting

Generalise the phenomena observed by experimenting different initial conditions, paramterisations, stochastic elemnts, etc.

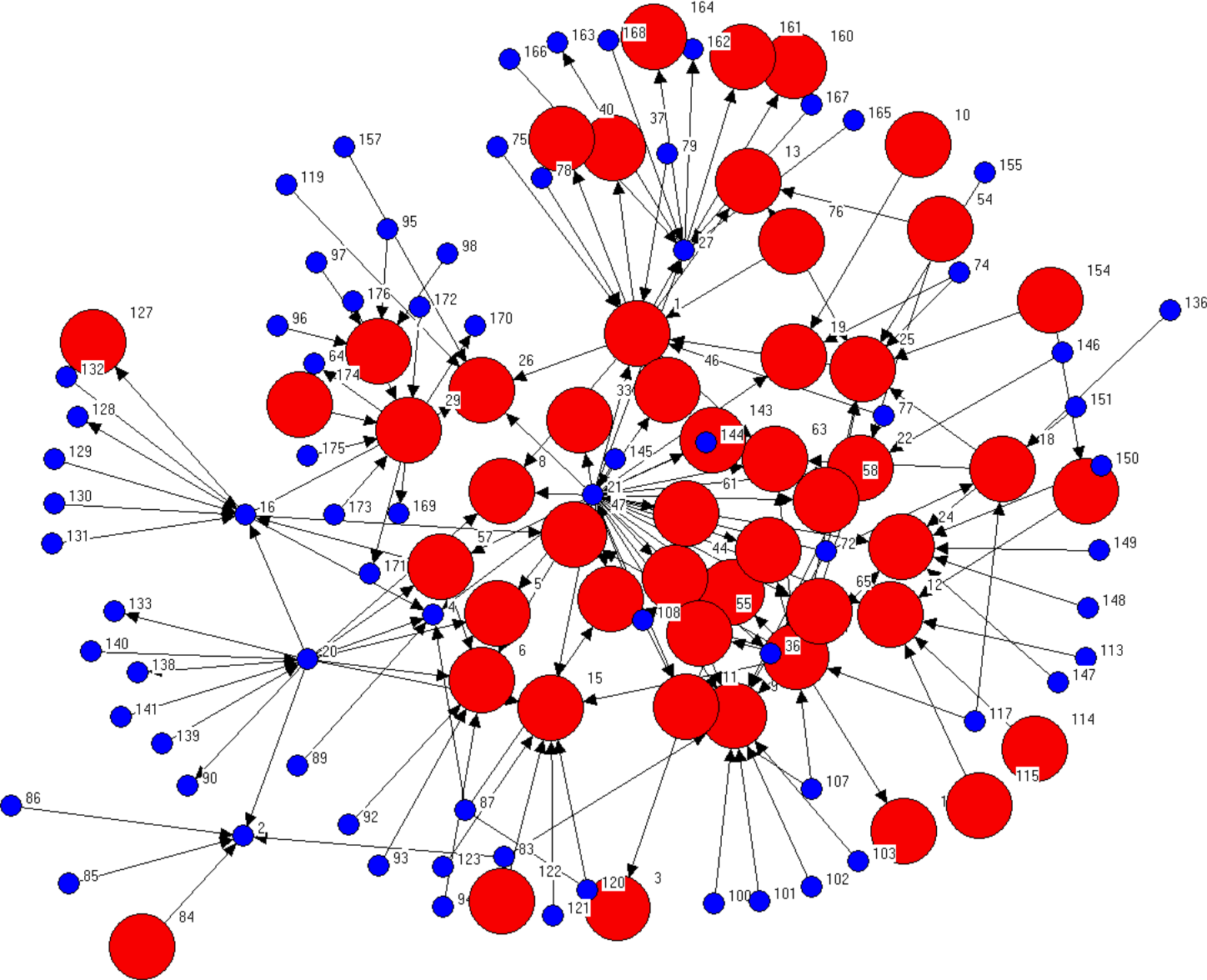
Main indicators of Costa Rica development

- Macro:** i) relatively high growth attainments, ii) relatively stable macro environment (inflation), iii) but unstable growth rates, iv) increase in consumption, services, non tradables, and decrease in investment, v) dependency on external variables \mapsto Low domestic investment, high FDI
- Trade:** i) growing exports, ii) negative TB, iii) export growth linked to FDI in the '90s (more than 50% of value), iv) growth (oscillations) linked to export \mapsto Relevance of external demand & dependence on export price (ToT)
- Institutions:** i) good social indicators (HDI), ii) LIS biased toward alphabetisation and tertiary education, iii) poor NIS (& no private innovation) \mapsto No NSI, technology importer, with a qualified but scarce HK

Main indicators of Costa Rica development (2)

Trade specialisation : i) no structural transformation & radical (exogenous) specialisation shift, ii) no transformation in domestic specialisation, iii) 5% of domestic exports in high tech \mapsto Dualistic development & structural heterogeneity

MNC behaviour : i) no local innovation ii) limited (5%) and low tech (95%) local procurement, iii) no interactive learning and limited tech transfer, iv) limited work mobility to local firms, v) weak relations with domestic institutions (only Universities).



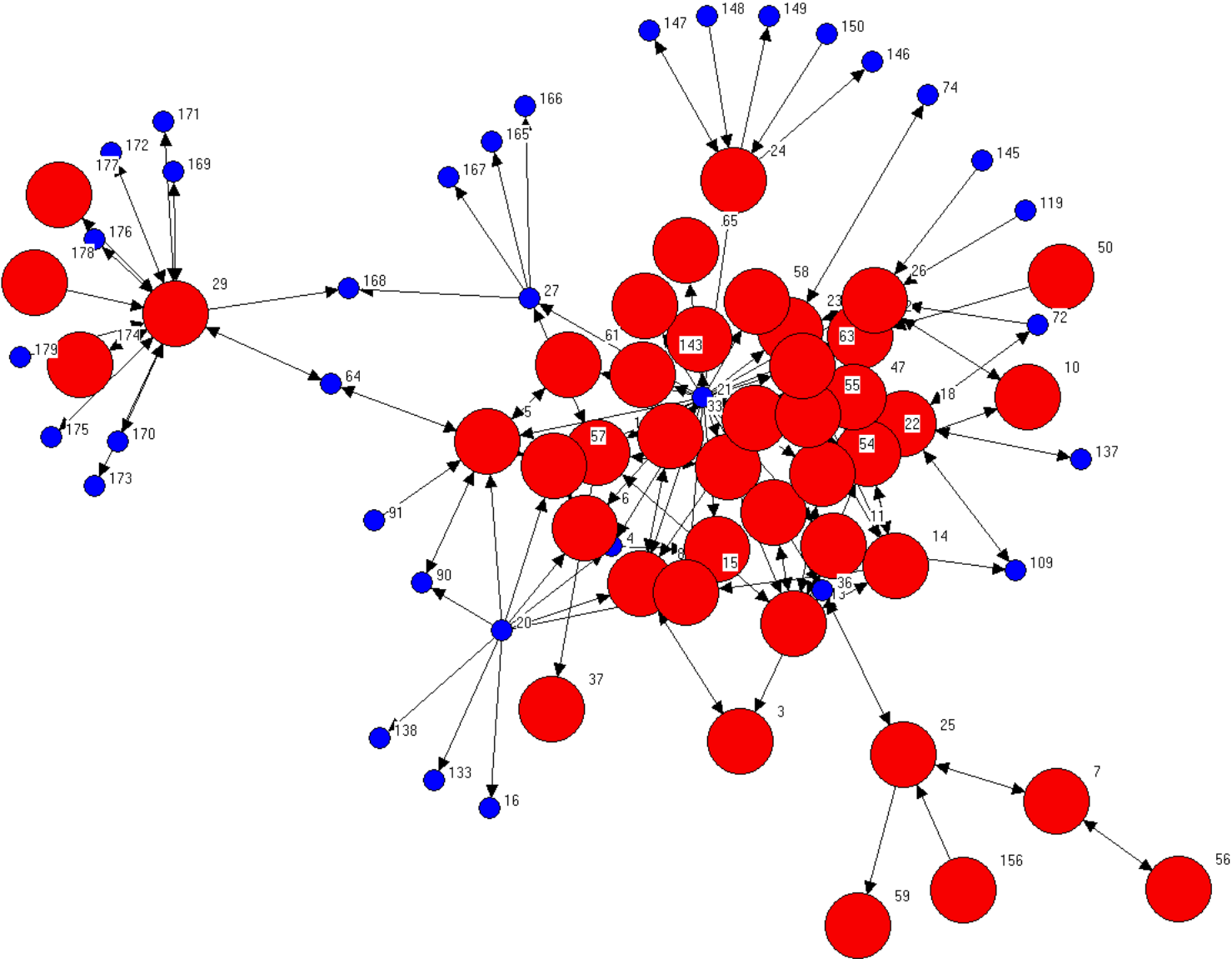


Figure 3: Foreign–Domestic knowledge linkages: ‘one shot’ knowledge transfers

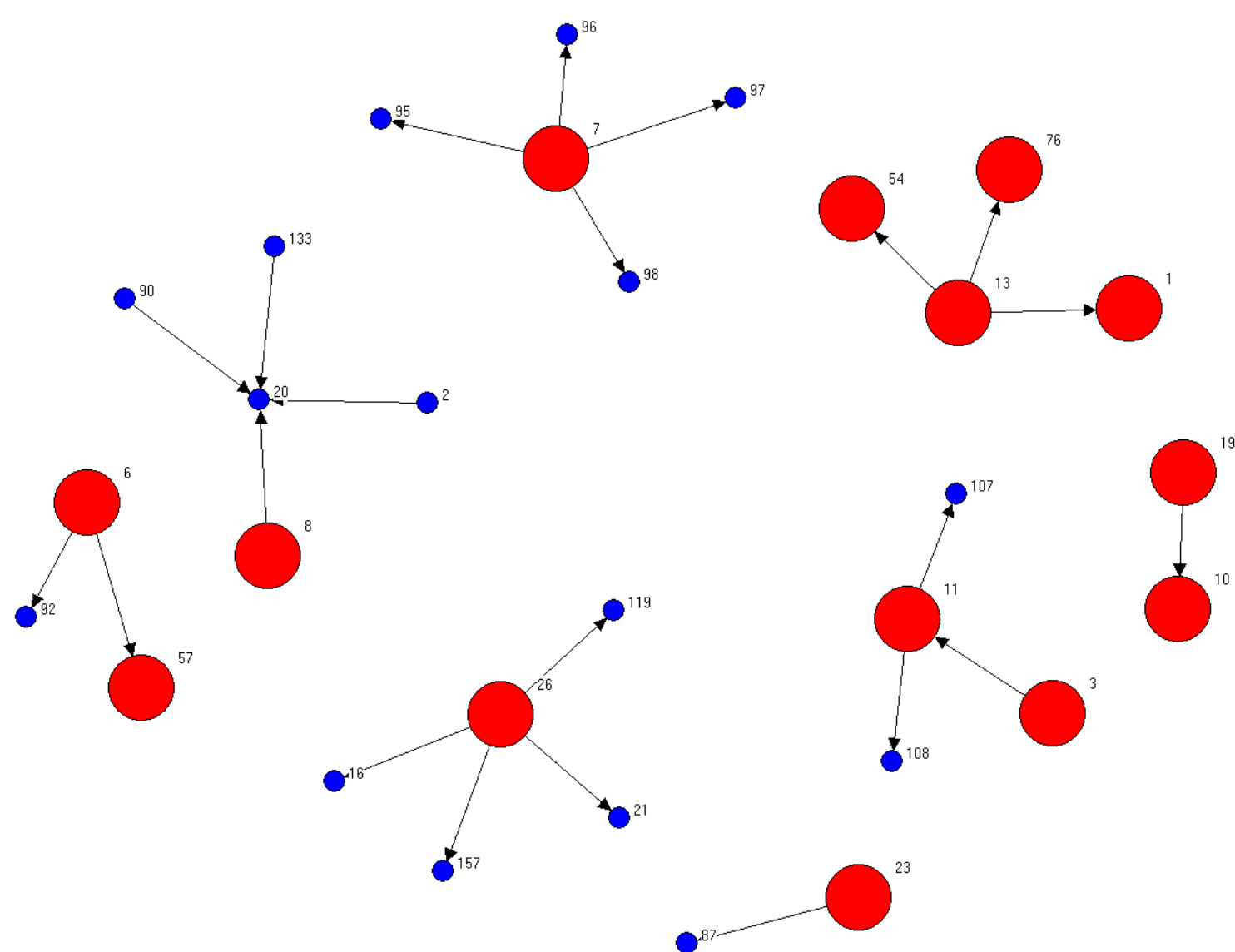
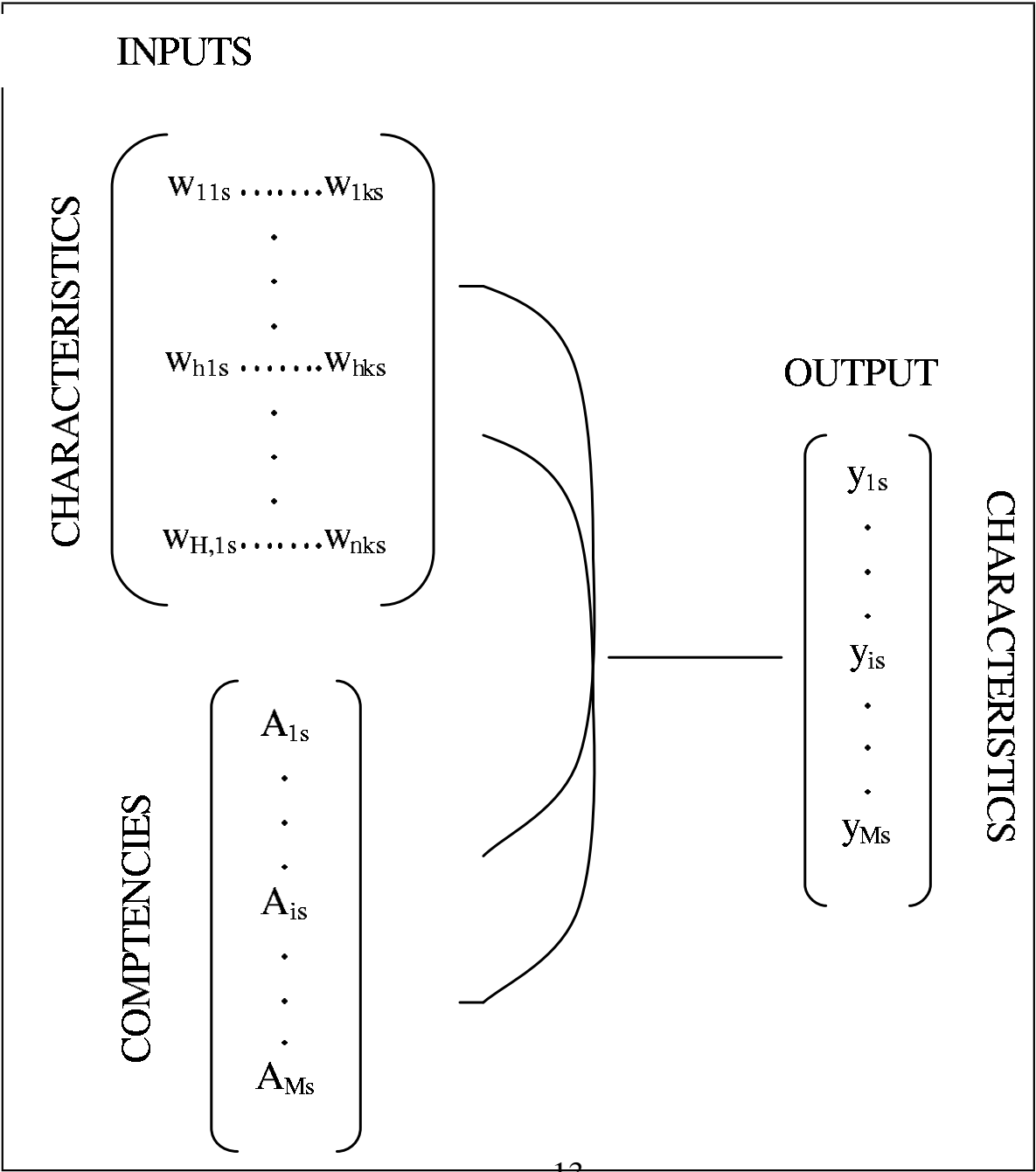


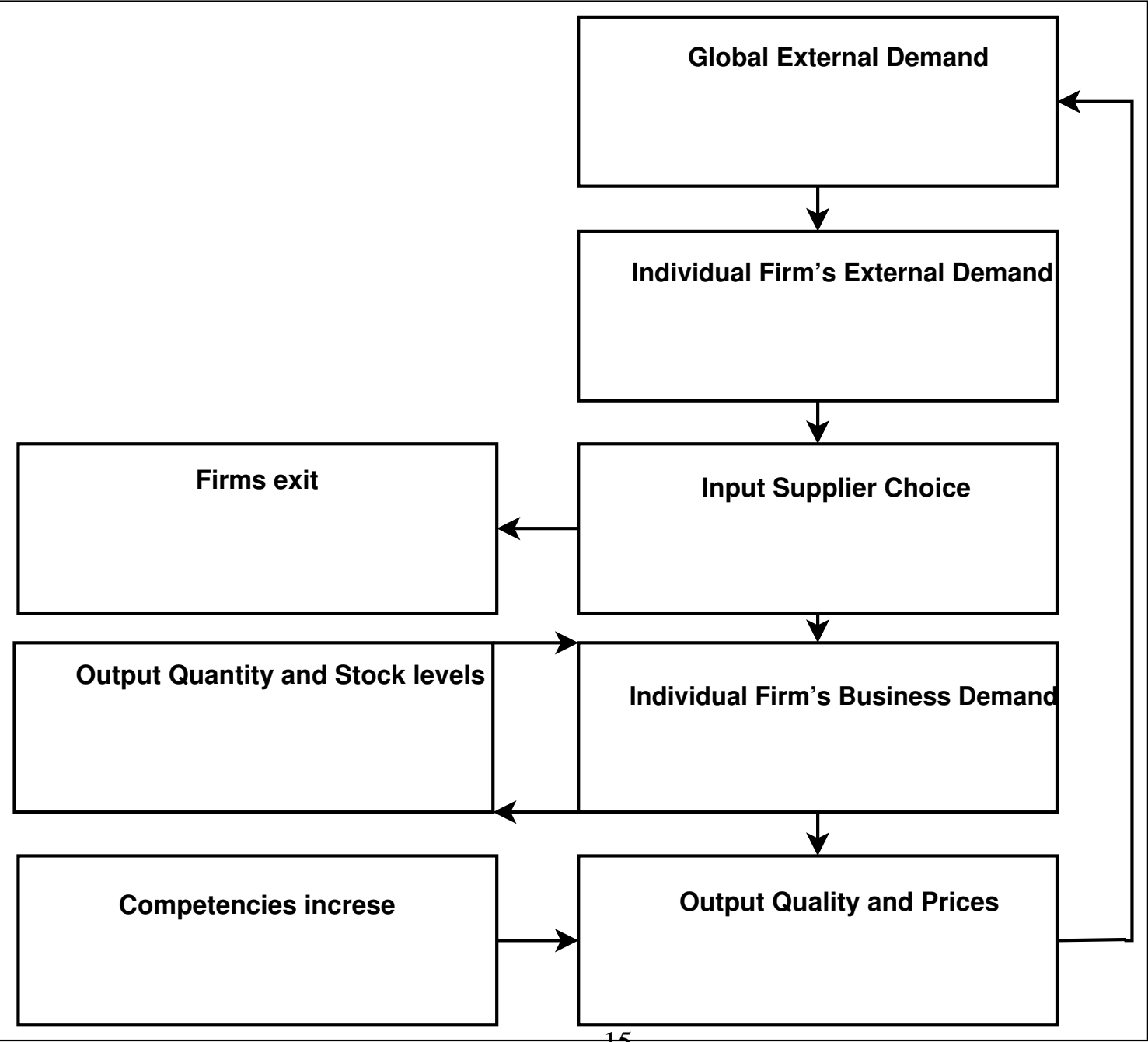
Figure 4: Foreign–Domestic knowledge linkages: strong and stable knowledge collabora

A firm-based input-output growth model

- The model represents one economic system composed by several sectors each supplying one product defined over a set of characteristics. Each sector is composed by an evolving set of firms (industrial dynamics).
- Firms within each sector produce a product defined over the same set of characteristics and use the same type of inputs, also defined over a set of characteristics.
- Firms can sell either to the final (export) D or to 'business' D, i.e. to firms in other sectors represented in the model. Both Ds depend on the quality of product's characteristics, price, and buyer's preferences.
- Firms produce through a Leontief technology: Q is determined simultaneously for all firms and responds to short periods orders, adjusting to the long period trend. D-S gaps adjust through stocks.
- Firms competencies increase through learning (path dependent) and innovation. Only firms in the final sector innovate randomly, involving suppliers with a given probability.



Model dynamics



Simulations Results

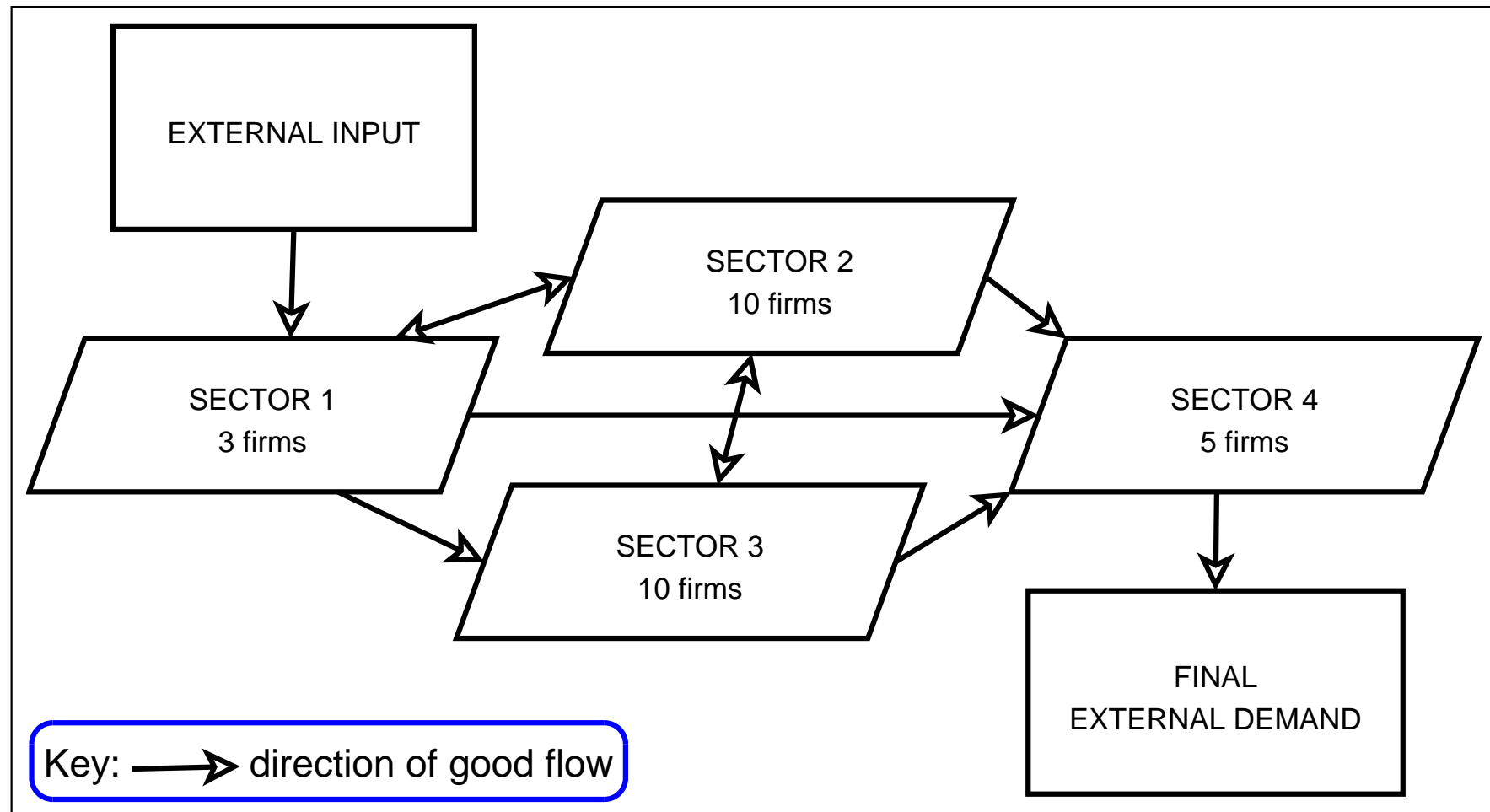
Model configuration

Initial setting with homogeneous sectors and firms

- No disembodied product innovation
- Sectors differ by firms entry timing and input coefficients
- Firm differ by i) initial competencies, ii) initial supplier, iii) timing in supplier choice
- Each good has five quality feature

Where not differently specified results represent the average over 10 simulations with different initial seeds.

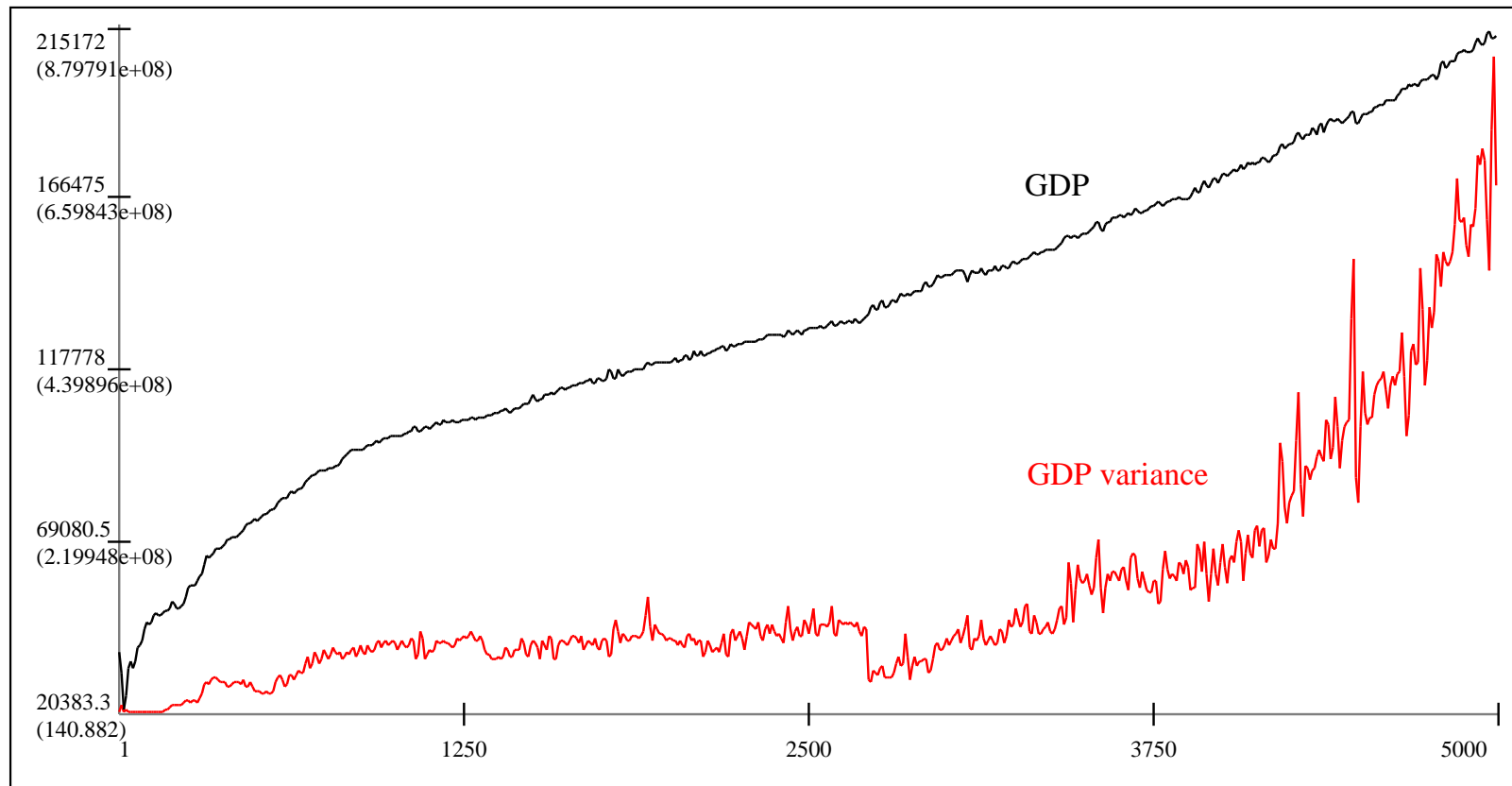
Figure 6: Structure of the economic system: Input–Output relations



Each input \mapsto 25 competencies to handle it.

Aggregate output growth

Figure 7: Output growth with homogeneous preferences



Where does the variance come from? Micro interactions & micro-meso interactions

Average quality growth

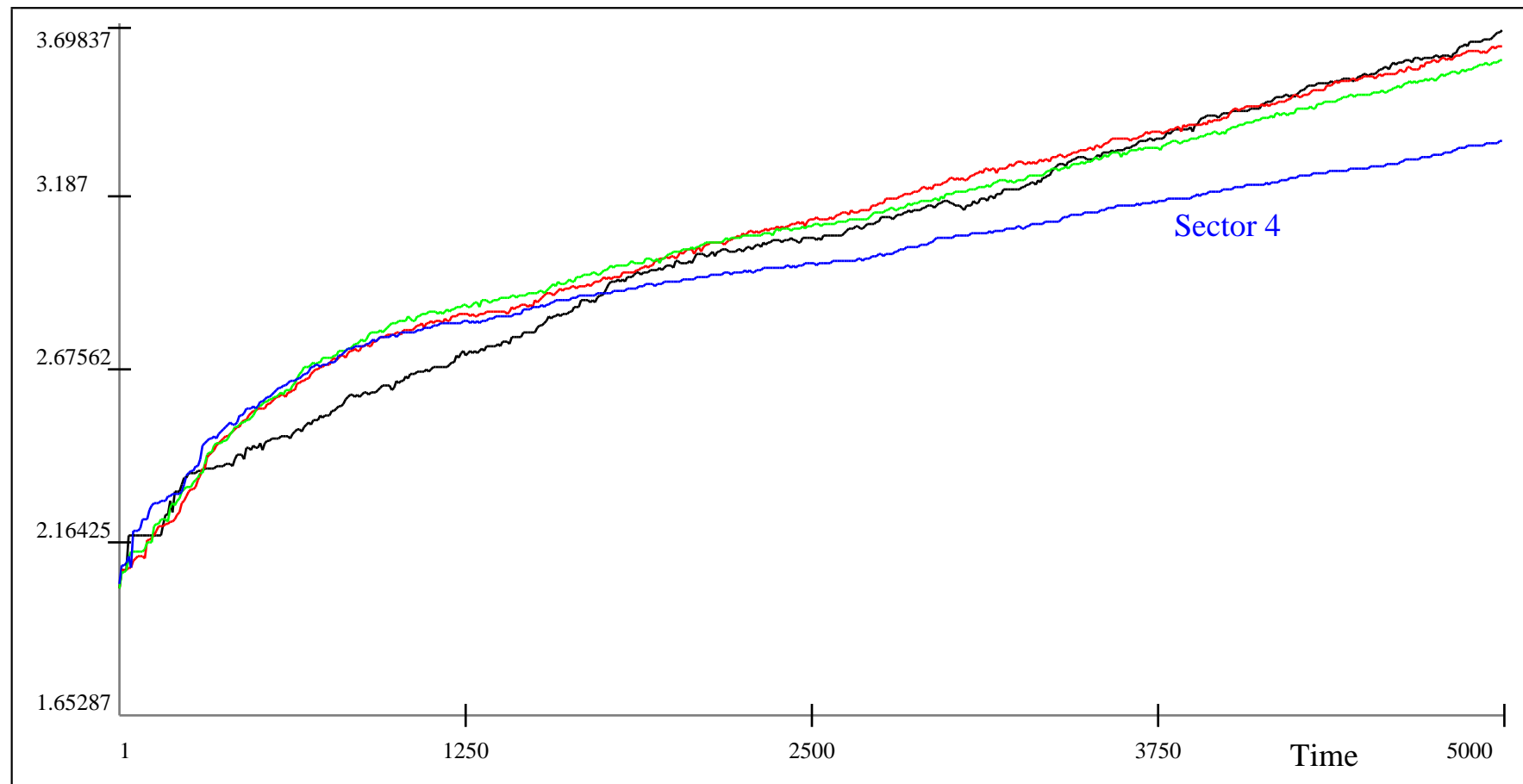


Figure 8: Growth of average qualities

Market indicator: concentration

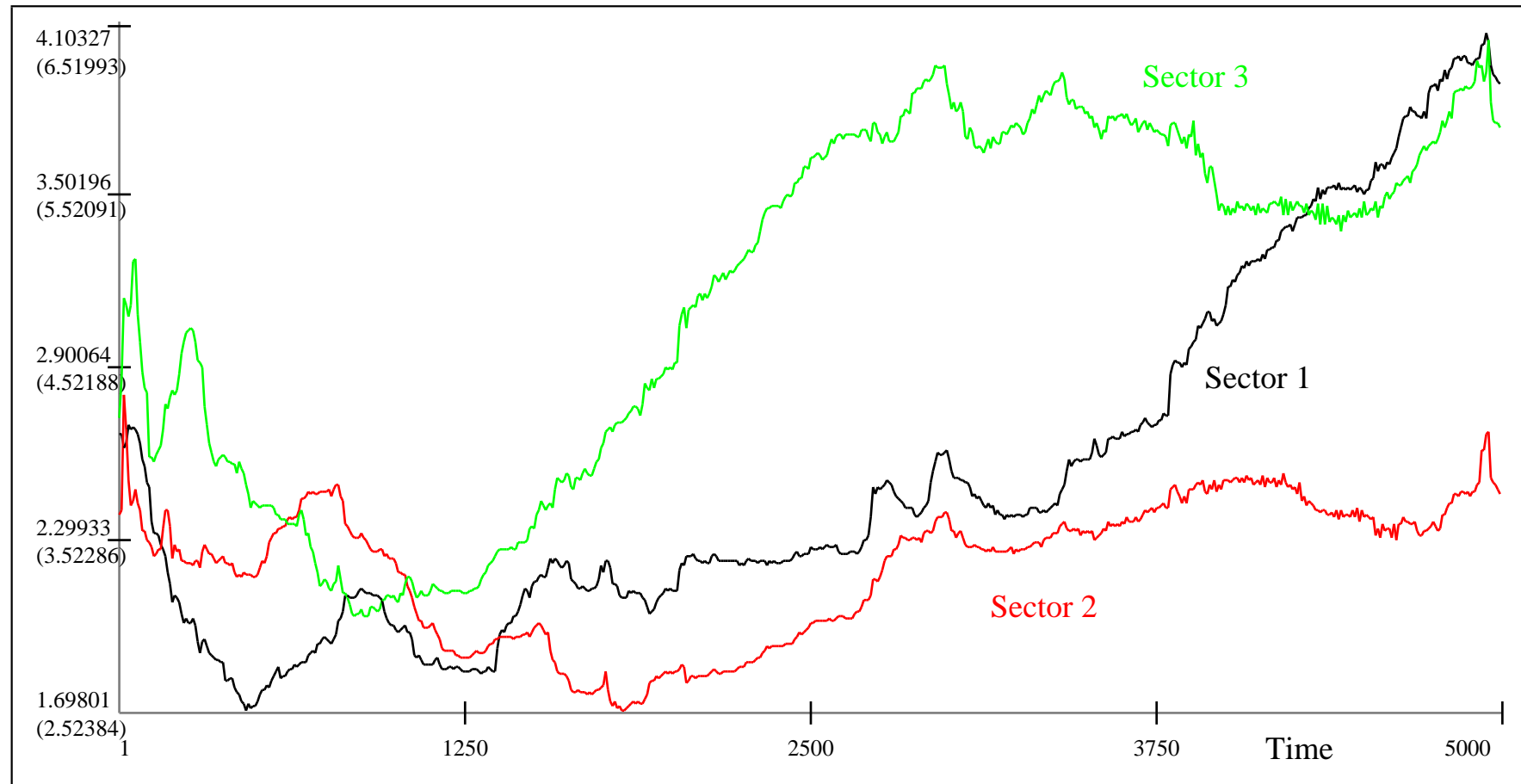
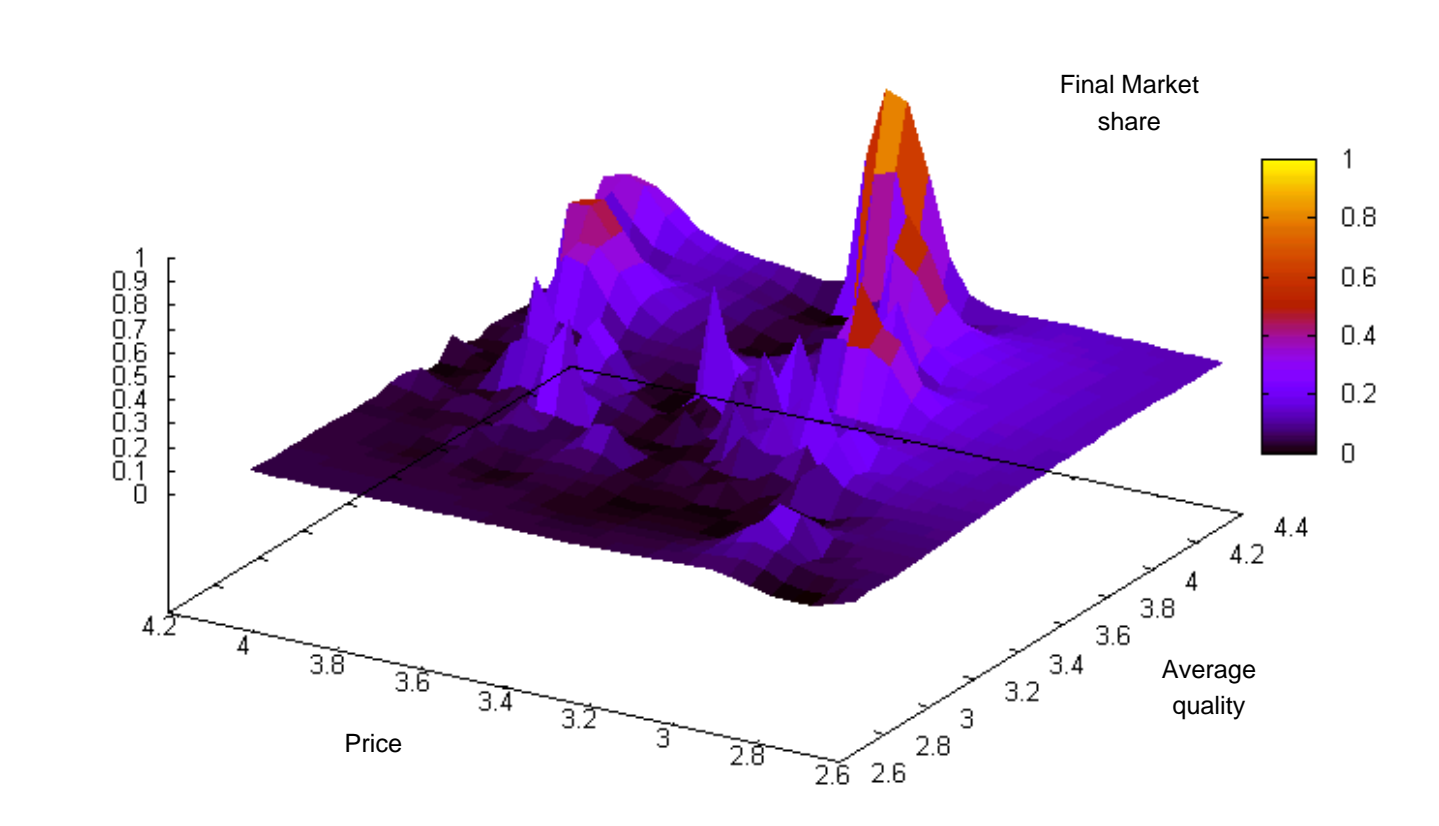


Figure 9: Sector concentration

Selection \mapsto **concentration** \mapsto **capabilities increase** \mapsto **successful entry**

Heterogeneous preferences: product specialisation and competitiveness



The imperfect choice of firms

Product specialisation and competitiveness: Leontieff and Kaldor paradox simulated

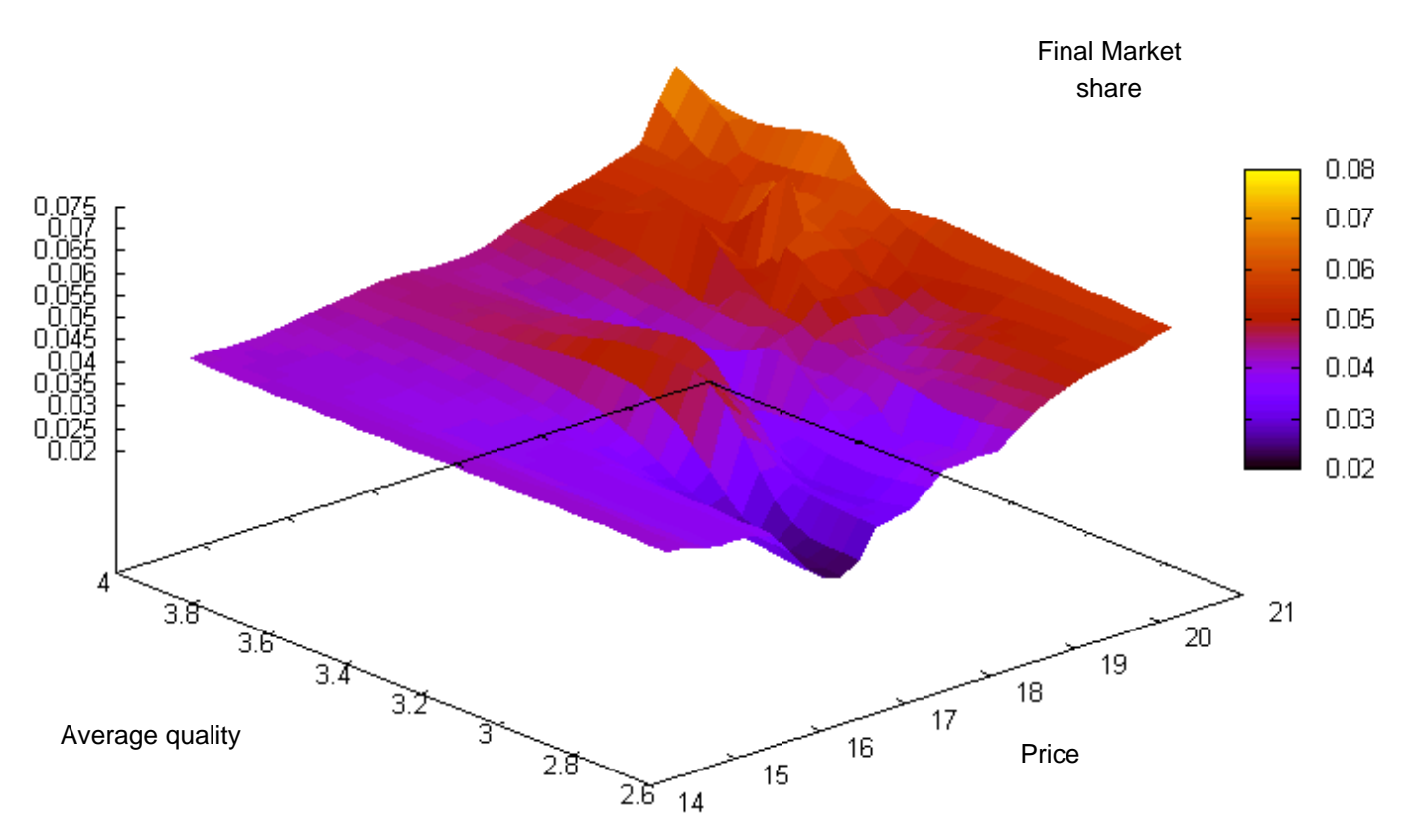
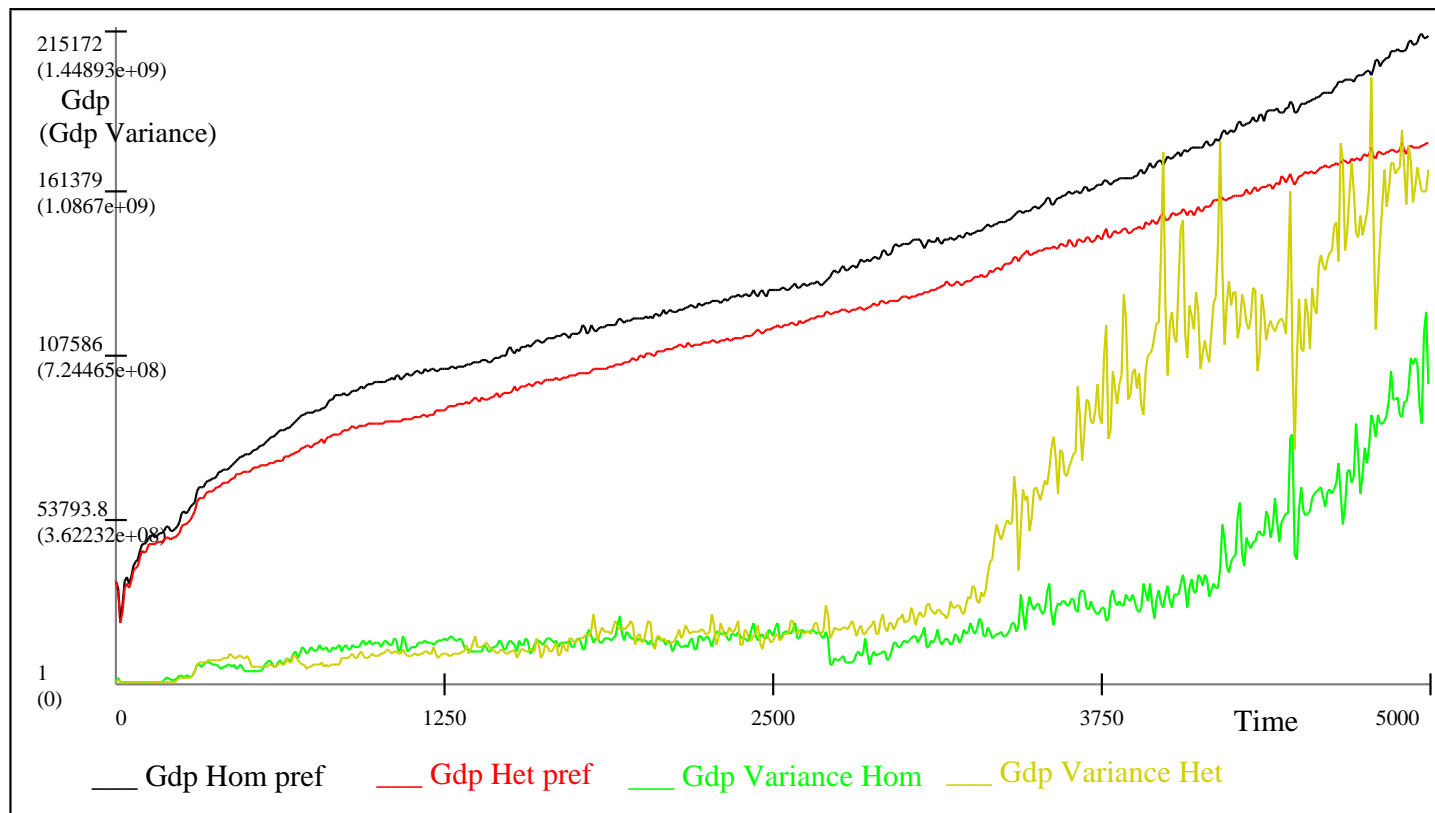


Figure 11: Quality and prices in the final sector

The selective choice of consumers'

Homogeneous and heterogeneous preferences compared

Figure 12: Aggregate output growth and variance



The effect interaction between consumers' preferences, firms' preferences, market structure and firms' capabilities \mapsto imperfect information

A lucky economic system?

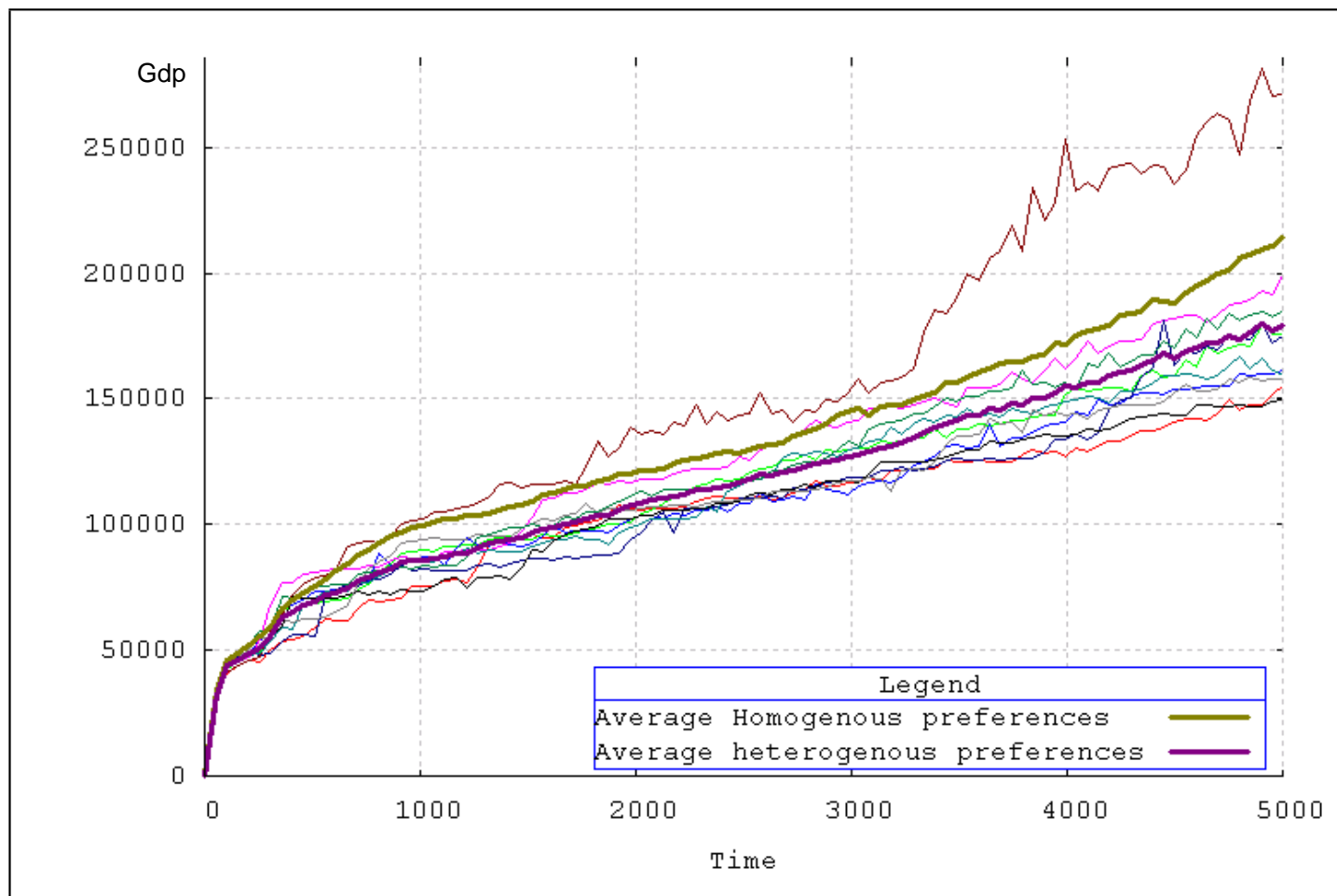
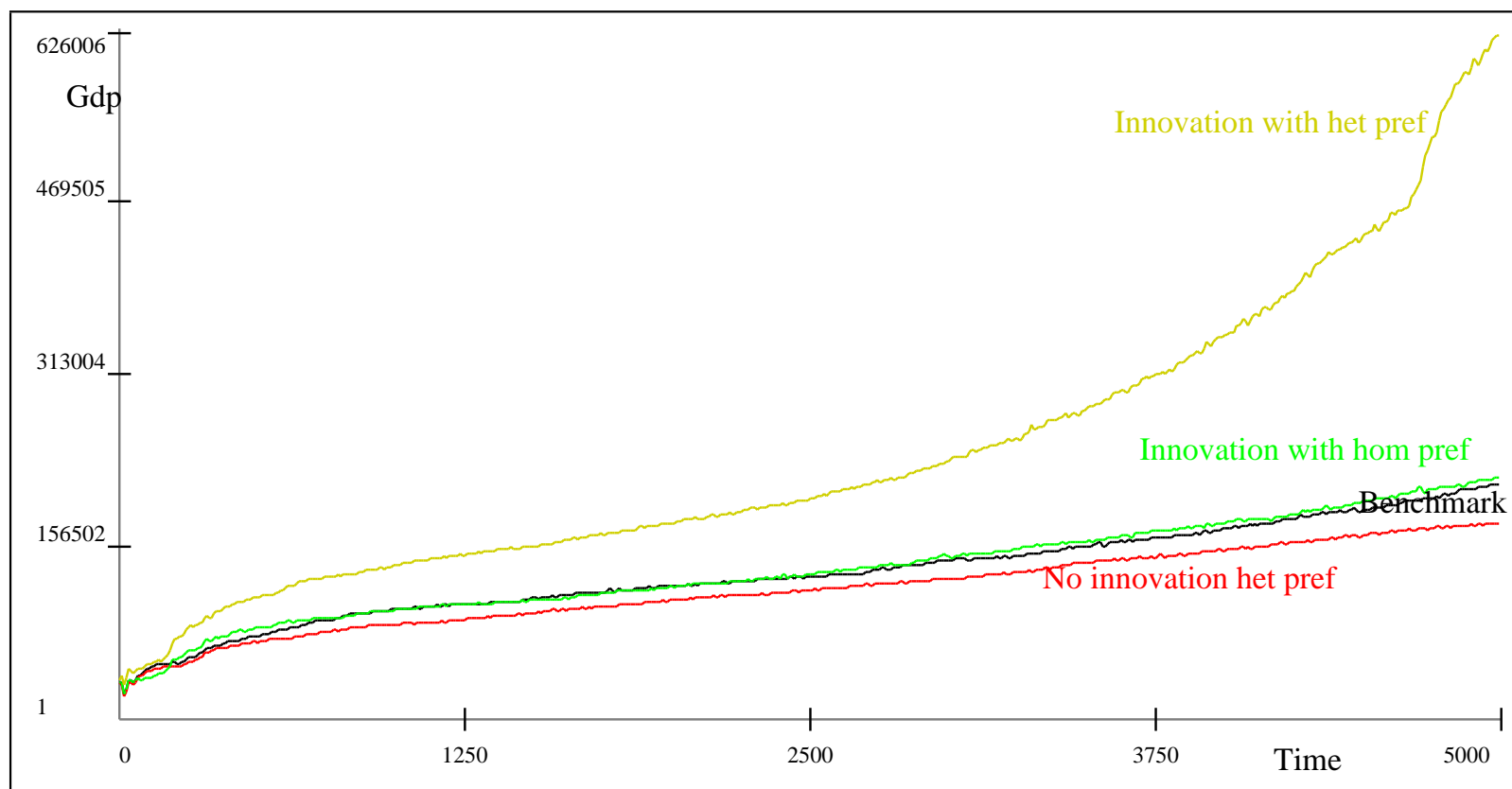


Figure 13: Output growth: comparing simulations with different seeds

An economic system with innovating firms: changing export specialisation

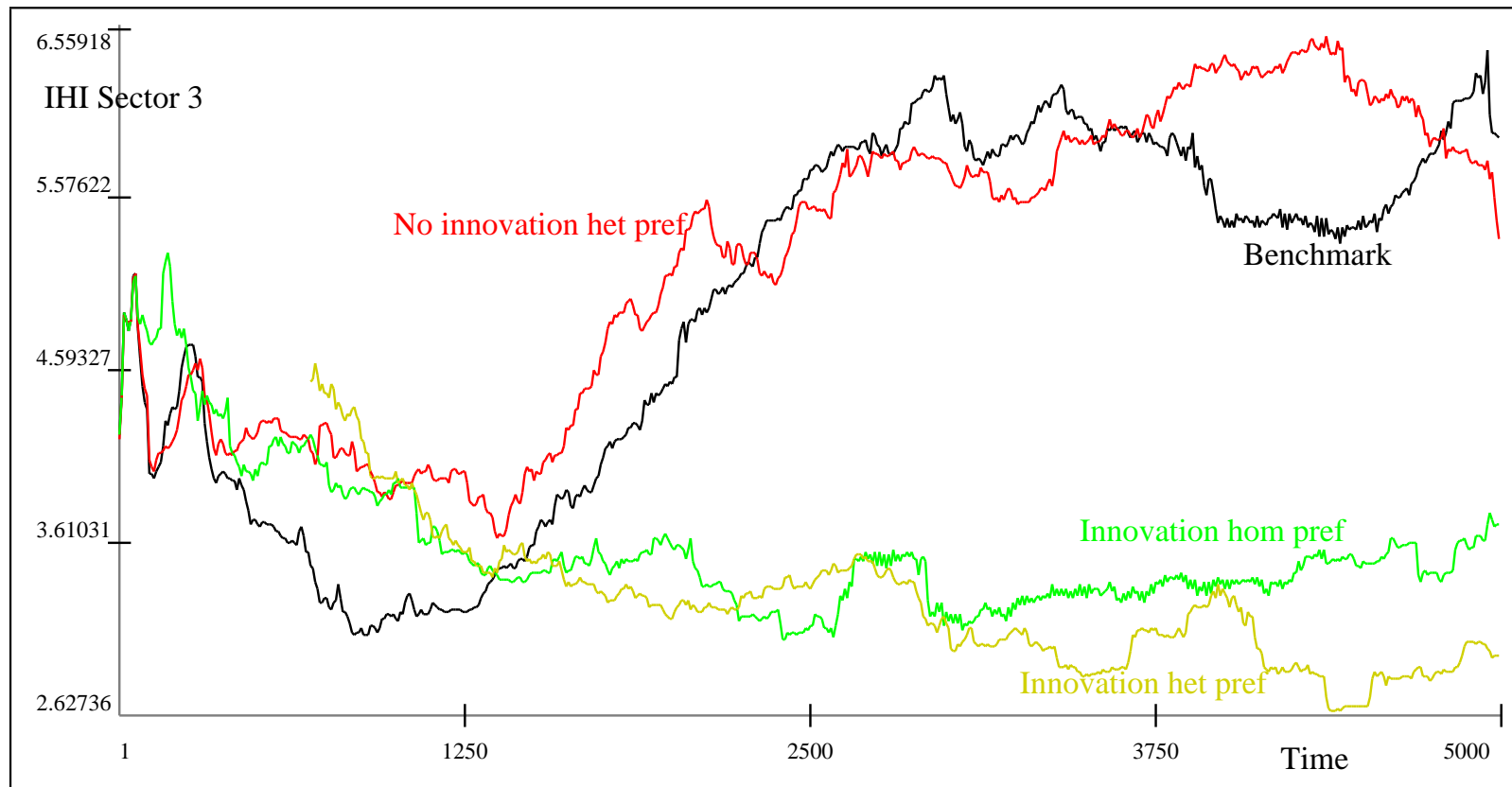
Figure 14: Output growth compared: innovating firms



Demand pull innovation induces changes in product specialisation of final sector firms and suppliers (.5 probability of interactive innovation)

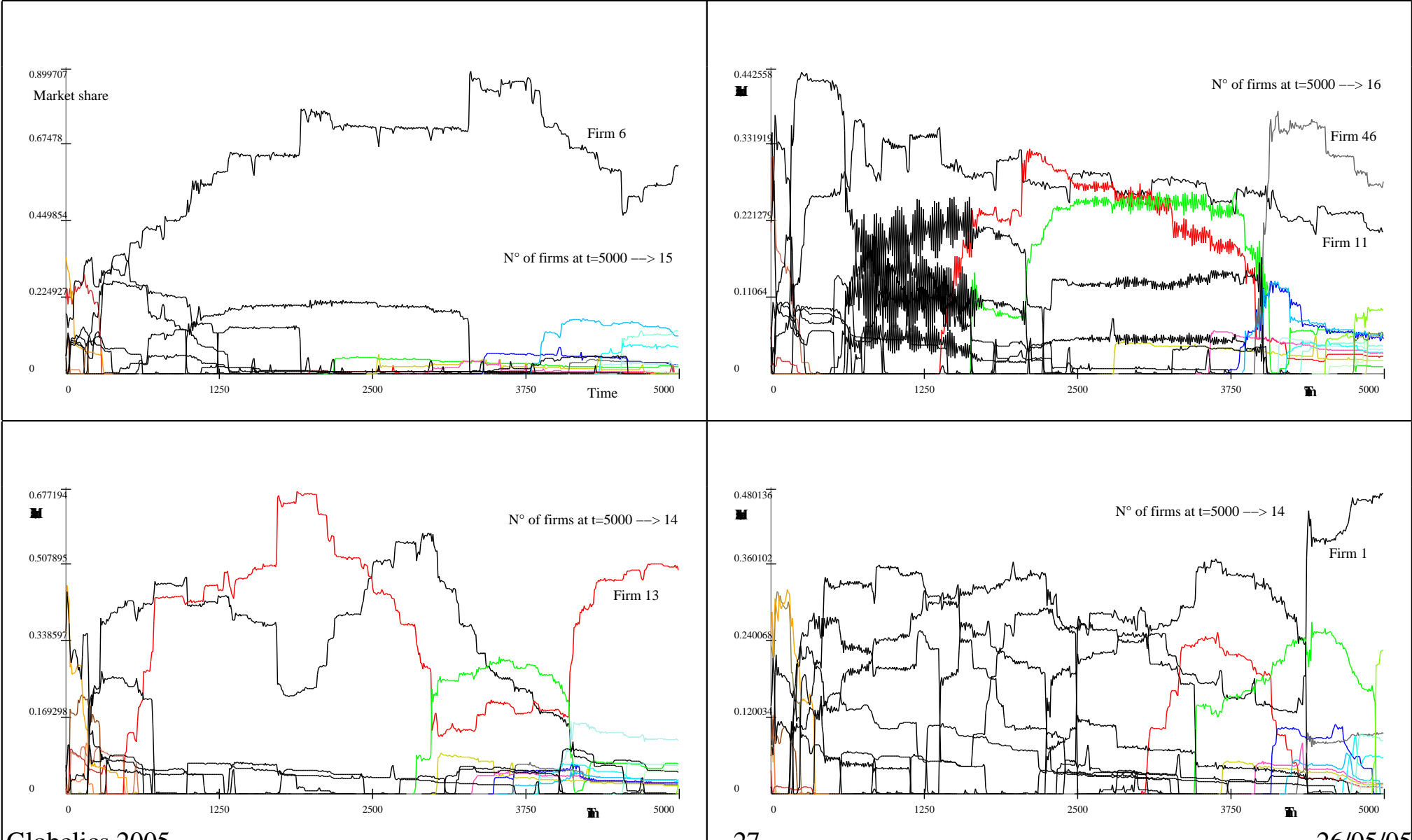
But lucky firms: within sector heterogeneity

Figure 15: Herfindahl index compared: market concentration with innovative firms



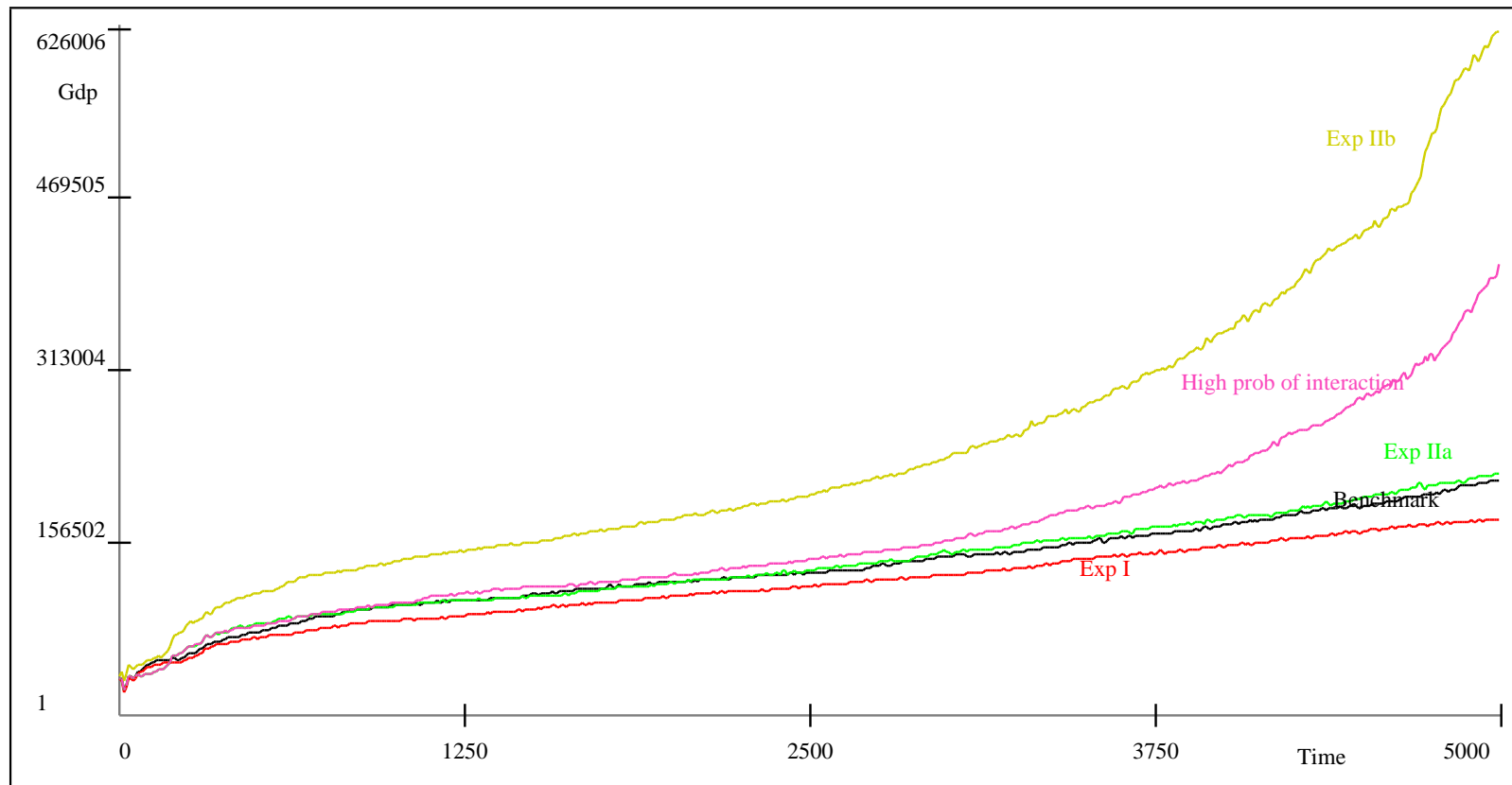
Path dependence: selected suppliers may participate in innovation \mapsto recursive dynamics \mapsto market polarisation

Figure 16: Industrial dynamics in sector 3 with innovation and heterogeneous preferences



Even more lucky: the relevance of user–supplier relations

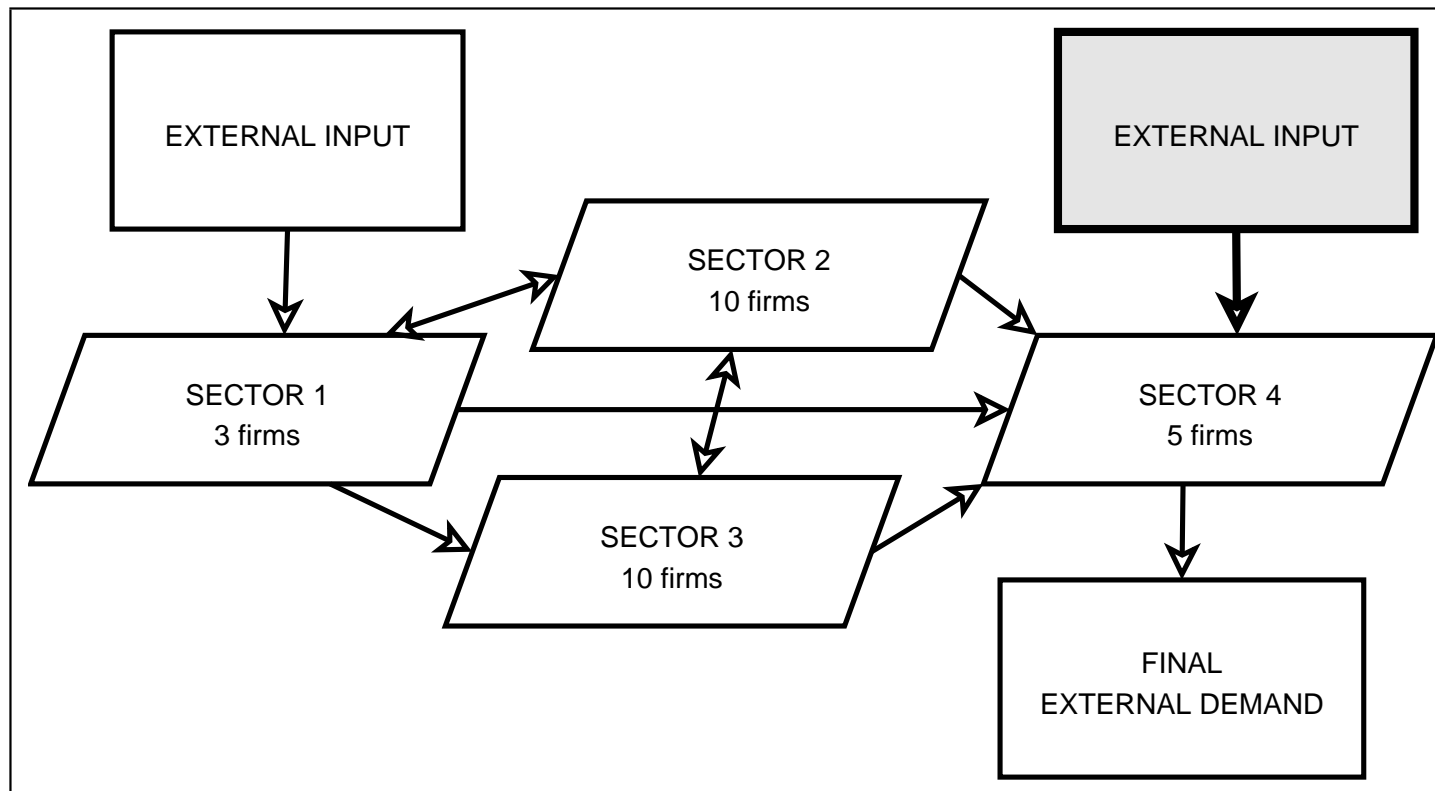
Figure 17: The effect of client–supplier innovation on aggregates



High probability of interacting (.75 - 1) benefits the entire system, even with no product specialisation

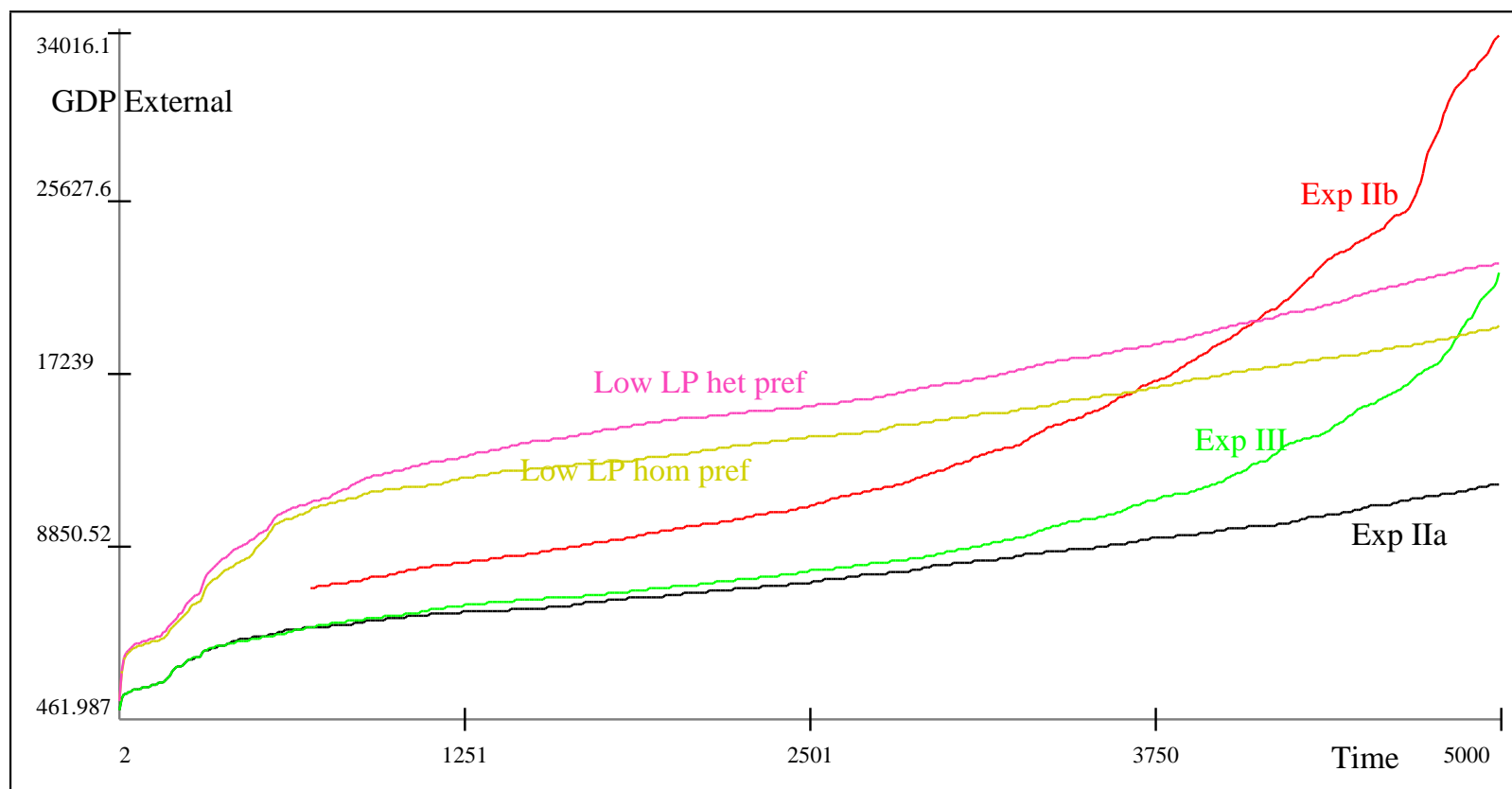
MNC local procurement

- Low local procurement (.2 - .12)
- External input for final sector
- Higher technological content of imported inputs (higher quality)



The gain of foreign investors

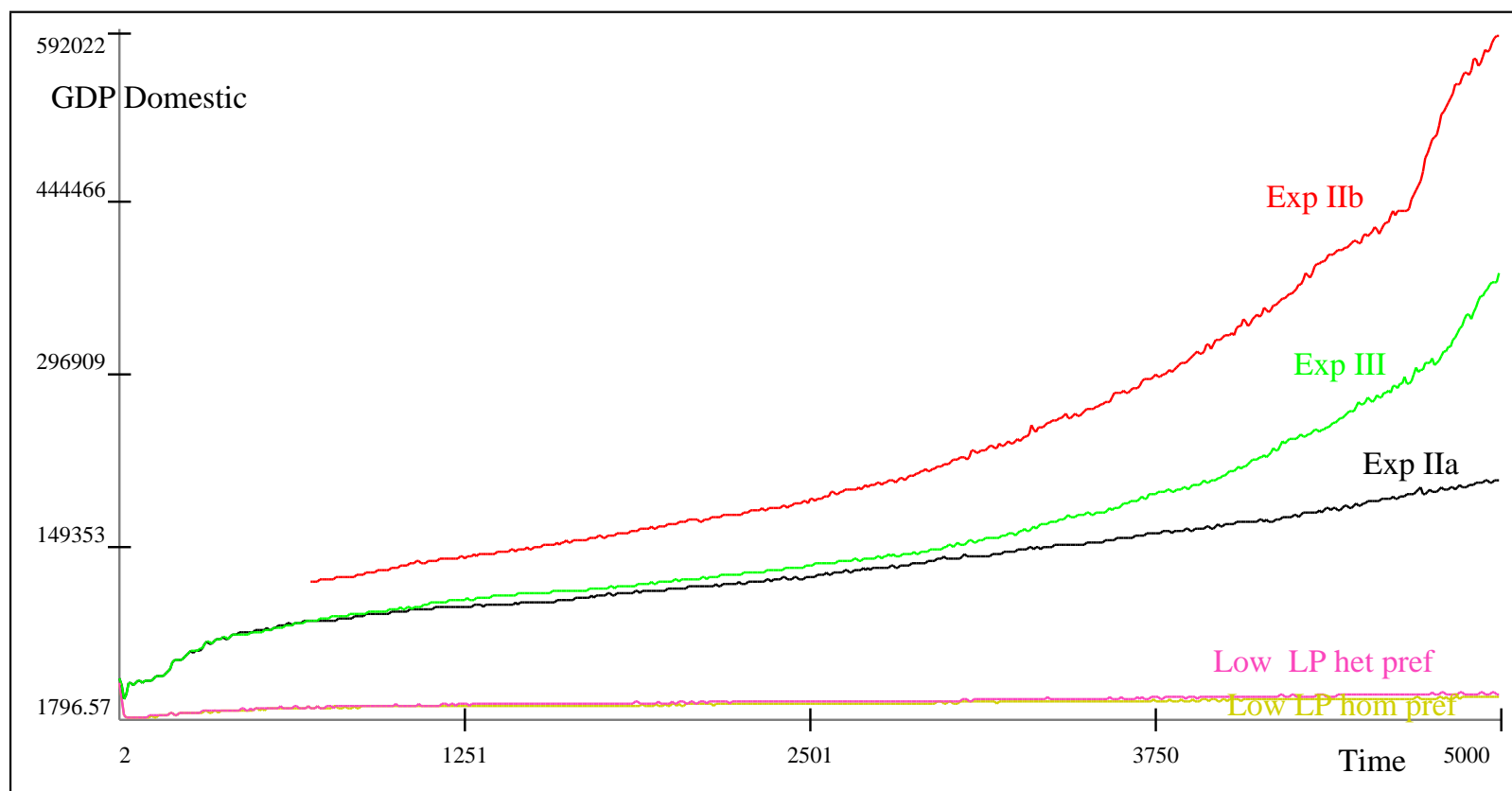
Figure 18: External output growth compared: different experiments



In spite of a lower growth of the economic system gain from MNC firms is higher, at least for a sufficient period

The loss of domestic industry...

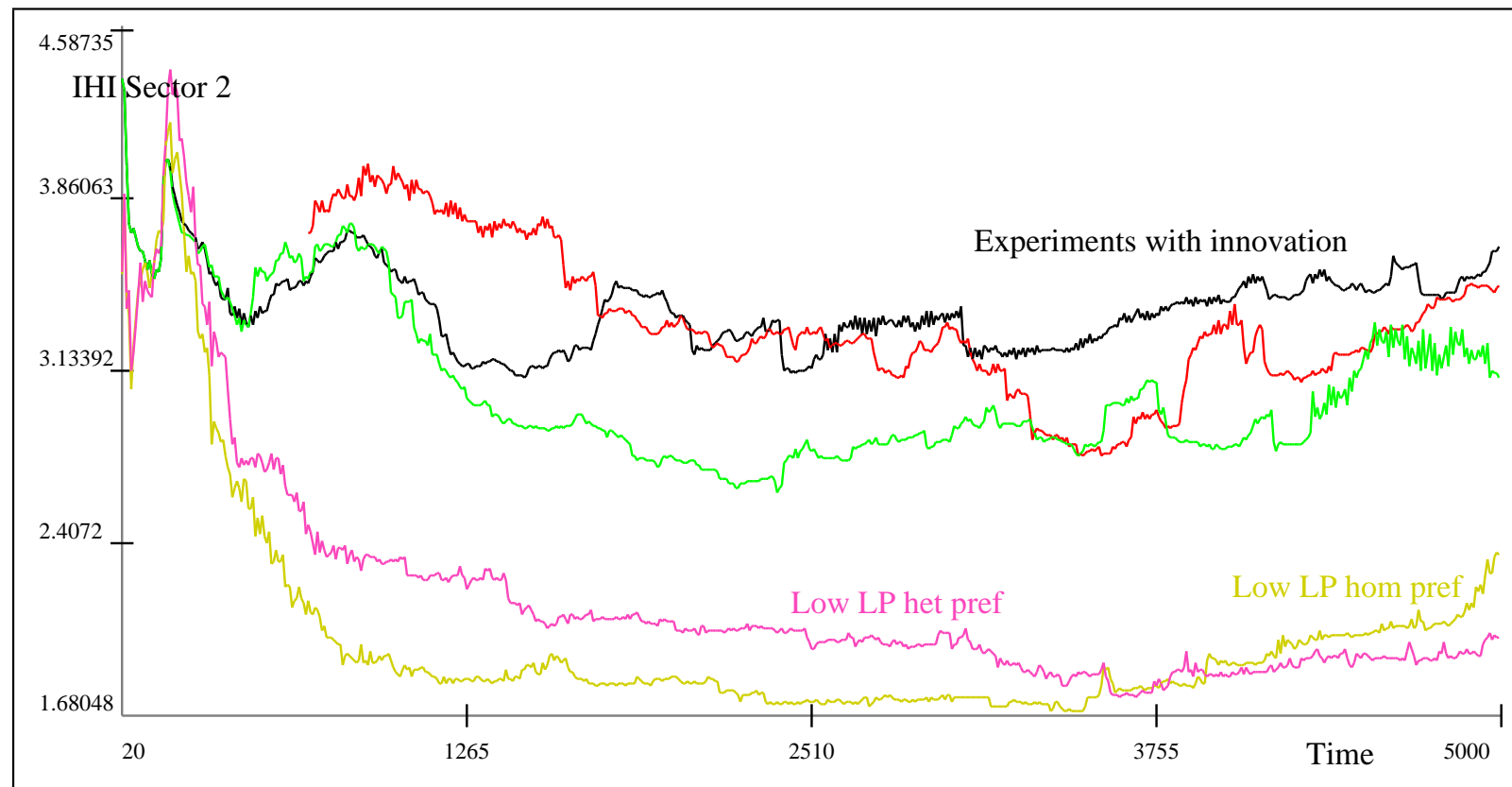
Figure 19: Domestic output growth compared: different experiments



Heterogeneous preferences still produce higher output

...with fewer luckier firms

Figure 20: Market shares in the 2nd sector compared



but the innovation process creates even more heterogeneity among domestic firms

Final consideration on Costa Rica pattern of development

We implement an interpretative micro based simulation model that may represent — NOT REPLICATE — different patterns of growth.

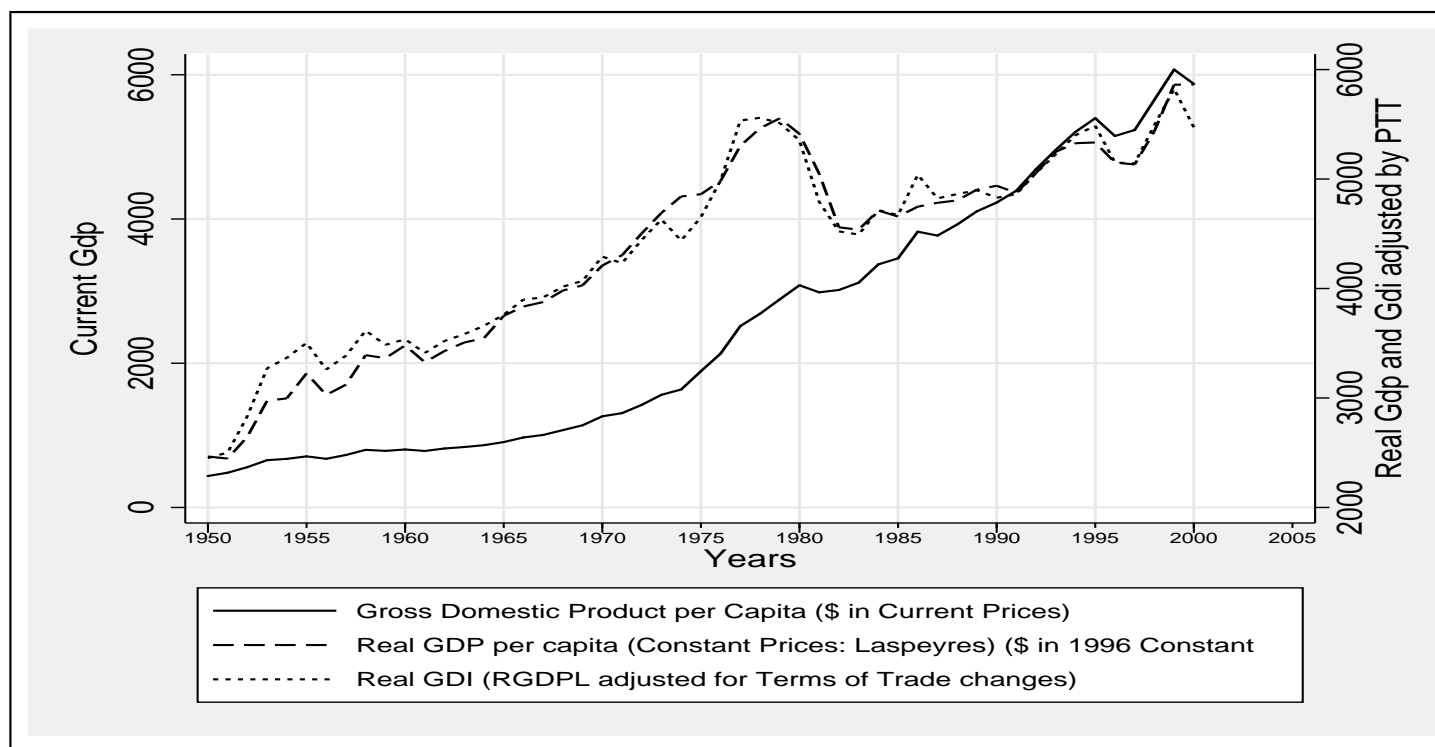


Figure 21: Costa Rica growth pattern

Analysis

- Use in depth empirical evidence
- Implement model mechanisms, heuristics and assumptions
- Use the model to interpret bottom–up dynamics and interaction between different levels of aggregation

Results

Experiment I & IIb (structural change): the recently established firms produce commodities that are dynamic on the international market, and keep incorporating innovations exogenously developed by the headquarters. So far so good.

Experiment III (interactive innovation): i) MNC undergo little innovation locally; ii) no interacting innovation but ones shot transfer; iii) sporadic knowledge linkages. So far less good

Experiment IV: limited involvement of the local system in the production process \mapsto fairly high GDP growth, low domestic output growth, no domestic structural change, low learning effect...

Low road to development